TMDL Nutrient Targets for Nearshore Waters of Lake Pend Oreille, ID – An Evaluation Using Long-Term Trophic and Periphyton Productivity Monitoring Data

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Idaho Department of Environmental Quality
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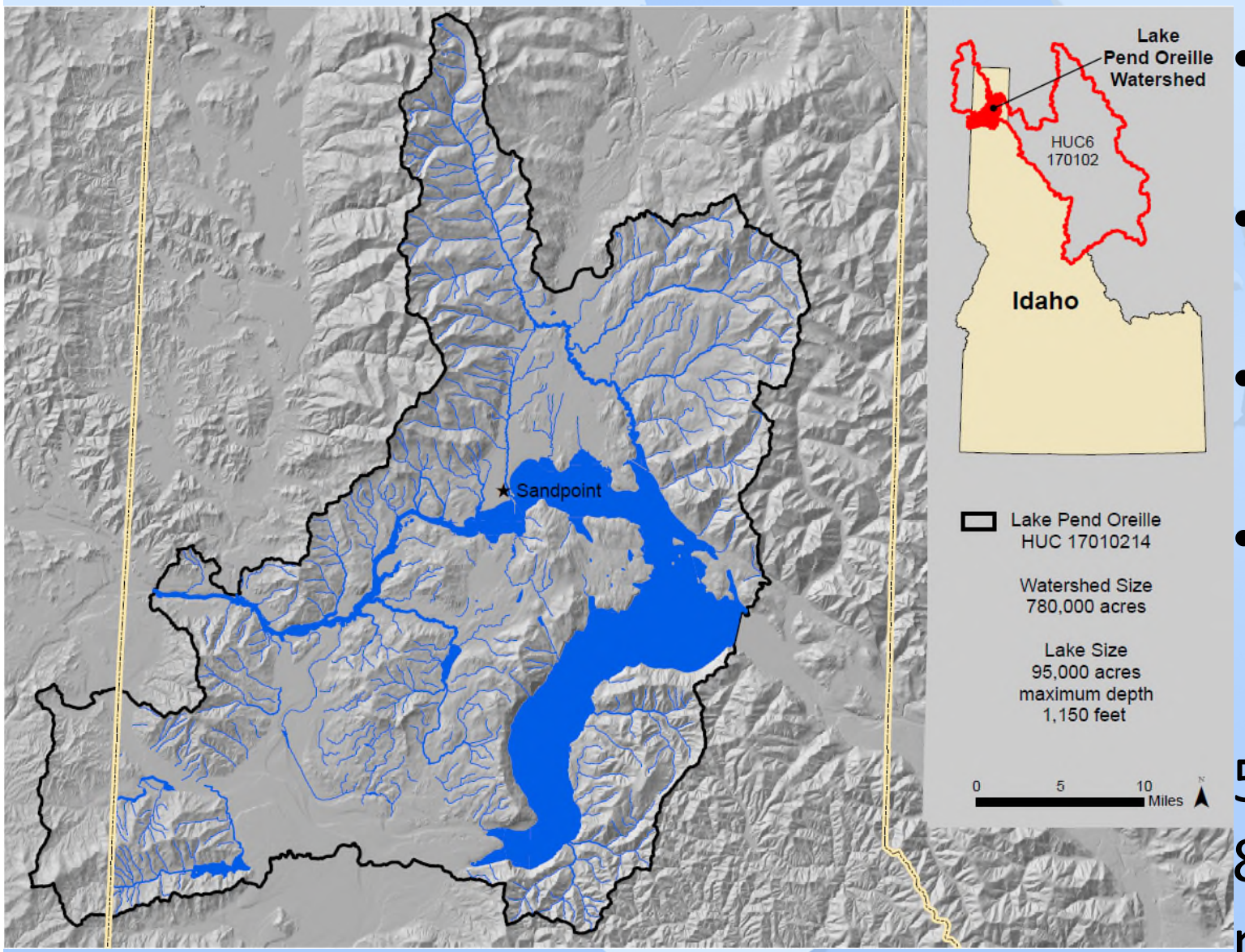
Lake Pend Oreille



- 329 km^2 (91,297 acres)
- mean depth = 164 m
- maximum depth = 357 m
- 111 miles of shoreline

5th deepest and 8th largest natural lake in the US

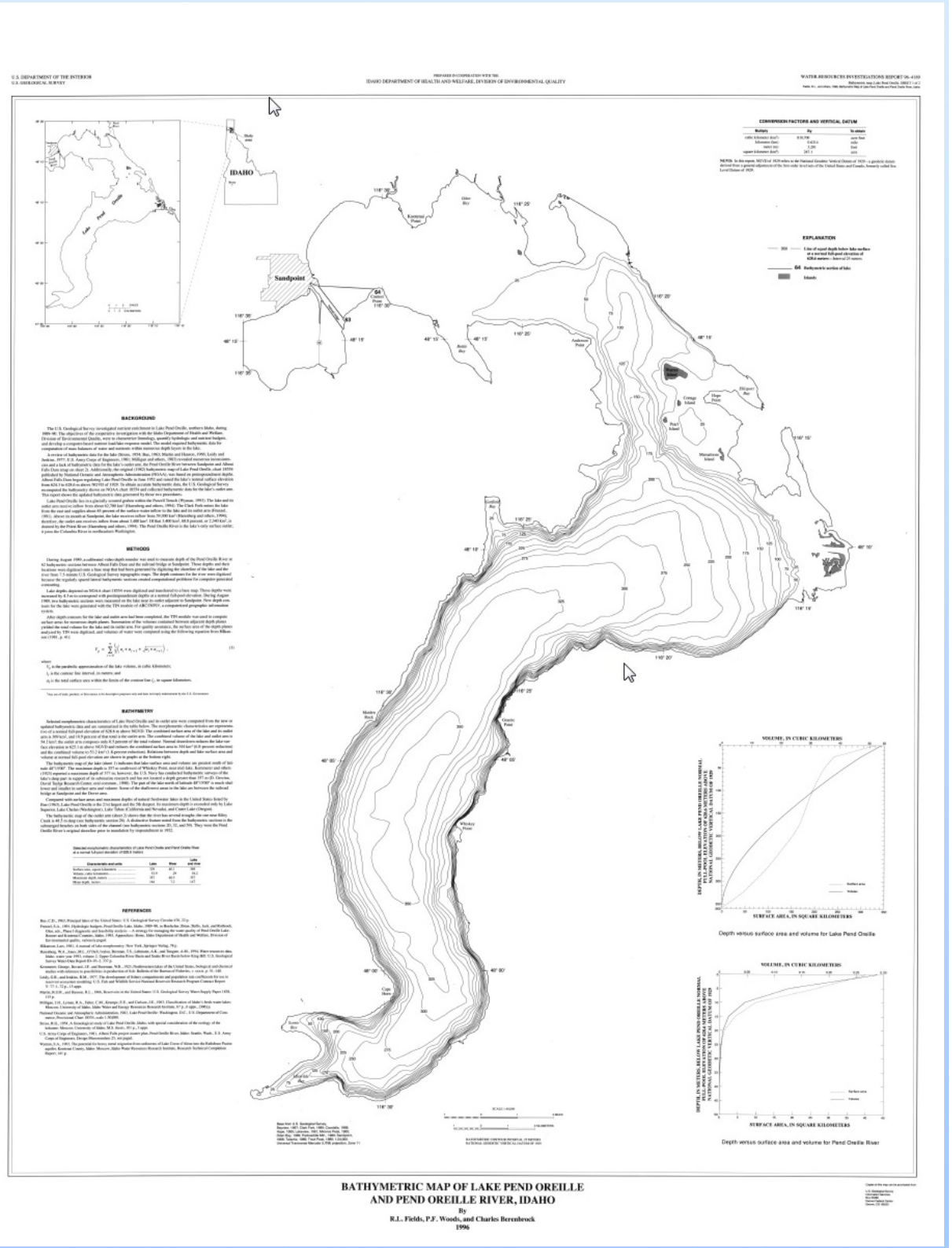
Lake Pend Oreille

- Largely surrounded by undeveloped forest - Much of it is managed by the US Forest Service
- Much of the terrain around the lake is very steep, which also precludes development.

Lake Pend Oreille

Development is in isolated locations around the lake
The biggest area being Sandpoint, ID on the northern shoreline of the lake.
Sandpoint and its surrounding area population is about 10,000 people (2010 Census)

- Lake Pend Oreille is divided it into two basins:
  - the deep southern end that contains approximately 95% of the lake's volume with HRT > 10 years .
  - the relatively well-flushed, shallow northern basin with HRT <1 year.



Lake Pend Oreille

- In 1987, Congress mandated a comprehensive water quality study in the Clark Fork-Pend Oreille Basin. Results (Frenzel 1991):
- Approximately 90% of the nitrogen and phosphorus load to Lake Pend Oreille comes from the Clark Fork River.
- The trophic status of the nearshore areas of Lake Pend Oreille was changing much more rapidly than the open waters.
- Development may be impacting water quality and productivity in the nearshore waters of the lake

Total Maximum Daily Load (TMDL) for Nutrients for the Nearshore Waters of Pend Oreille Lake, Idaho

Tri-State Water Quality Council
307 North 2nd Avenue
Suite 12
Sandpoint, Idaho 83864

April 2002

Montana and Idaho
Border Nutrient Load Agreement
TECHNICAL GUIDANCE

Presented to
Montana Department of Environmental Quality
Idaho Department of Environmental Quality

Submitted by
Tri-State Water Quality Council
Border Agreement Technical Team
307 North Second Avenue, Suite 12
Sandpoint, Idaho 83864

January, 2001

Are practices that have been implemented helping to reduce pollutants from entering the lake?

- Education
- Citizen Monitoring
- Development/Shoreline Ordinances
- Invasive Species Control
- Pump-out Facilities
- Wastewater Treatment Upgrades
- Clark Fork Delta Habitat Restoration
- Pack River Habitat Restoration

TMDL Targets

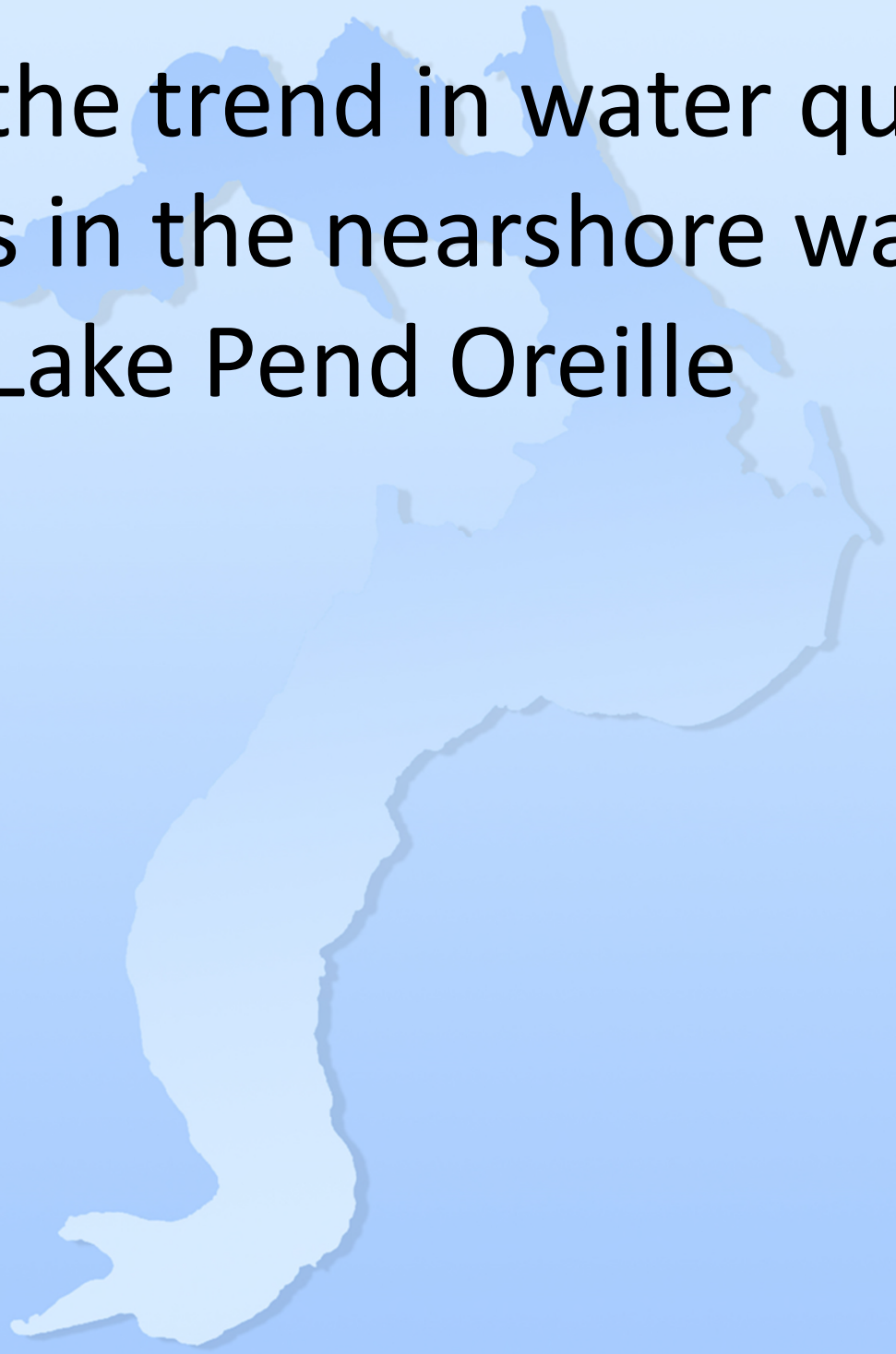
- 9 µg/L target to represent an average total phosphorus concentration throughout the nearshore waters of the lake.
- Targets are based on the assumption that the impairment to the nearshore waters is from periphyton (attached bottom algae) in the littoral zone of the lake.

TMDL 5-Year Review Approach

The goals of the five-year review of the *TMDL for Nutrients for the Nearshore Waters of Pend Oreille Lake, Idaho* are to answer the following questions:

- What is the trend in water quality parameters in the nearshore waters of Lake Pend Oreille
- Are water quality targets in the TMDL being met?
- How does the water quality and targets in the TMDL relate to productivity in the nearshore waters of Lake Pend Oreille?
- The TMDL assumes that the dominant factor affecting nearshore water quality is loading from the immediate nearshore drainage area, not from tributaries. Is this assumption valid?
- What practices have been implemented to reduce pollutants from entering the lake?

What is the trend in water quality parameters in the nearshore waters of Lake Pend Oreille

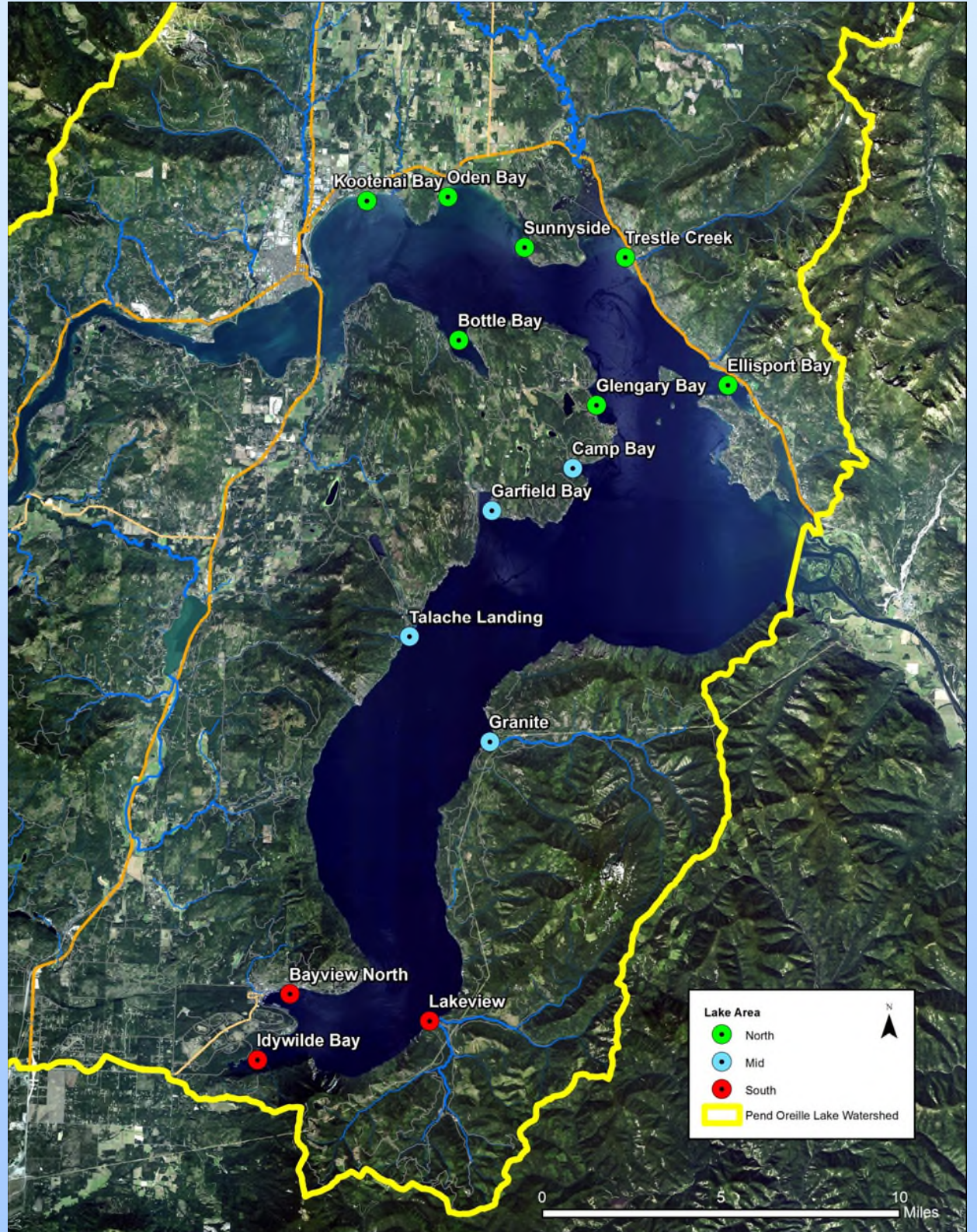


Water Quality Monitoring

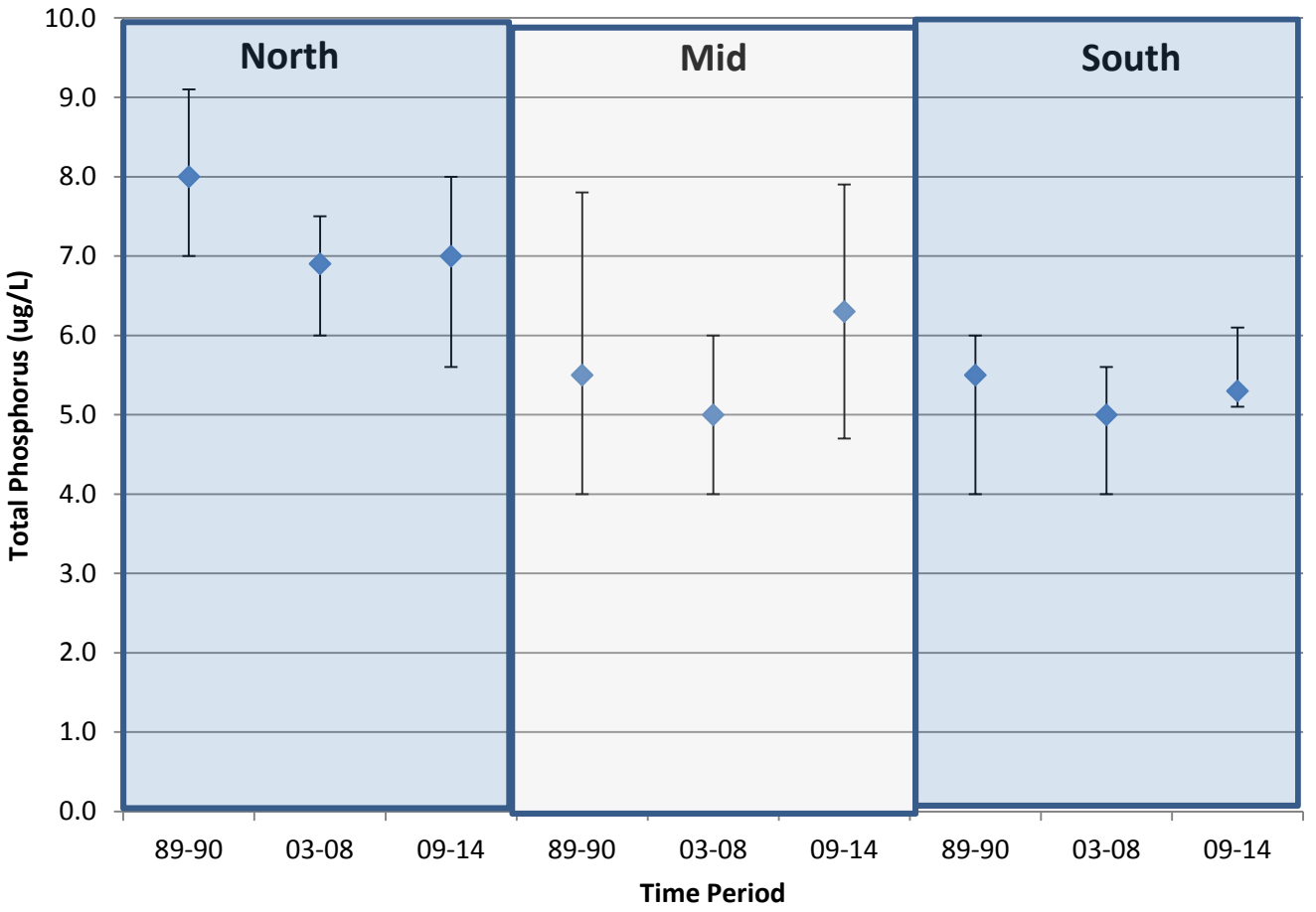
- C. M. Falter (U of I) Studies: 1989, 1990, 2003
- Tri-State Water Quality Council: 2006-2008
- IDEQ: 2009, 2012, 2013, 2014

Trophic Monitoring

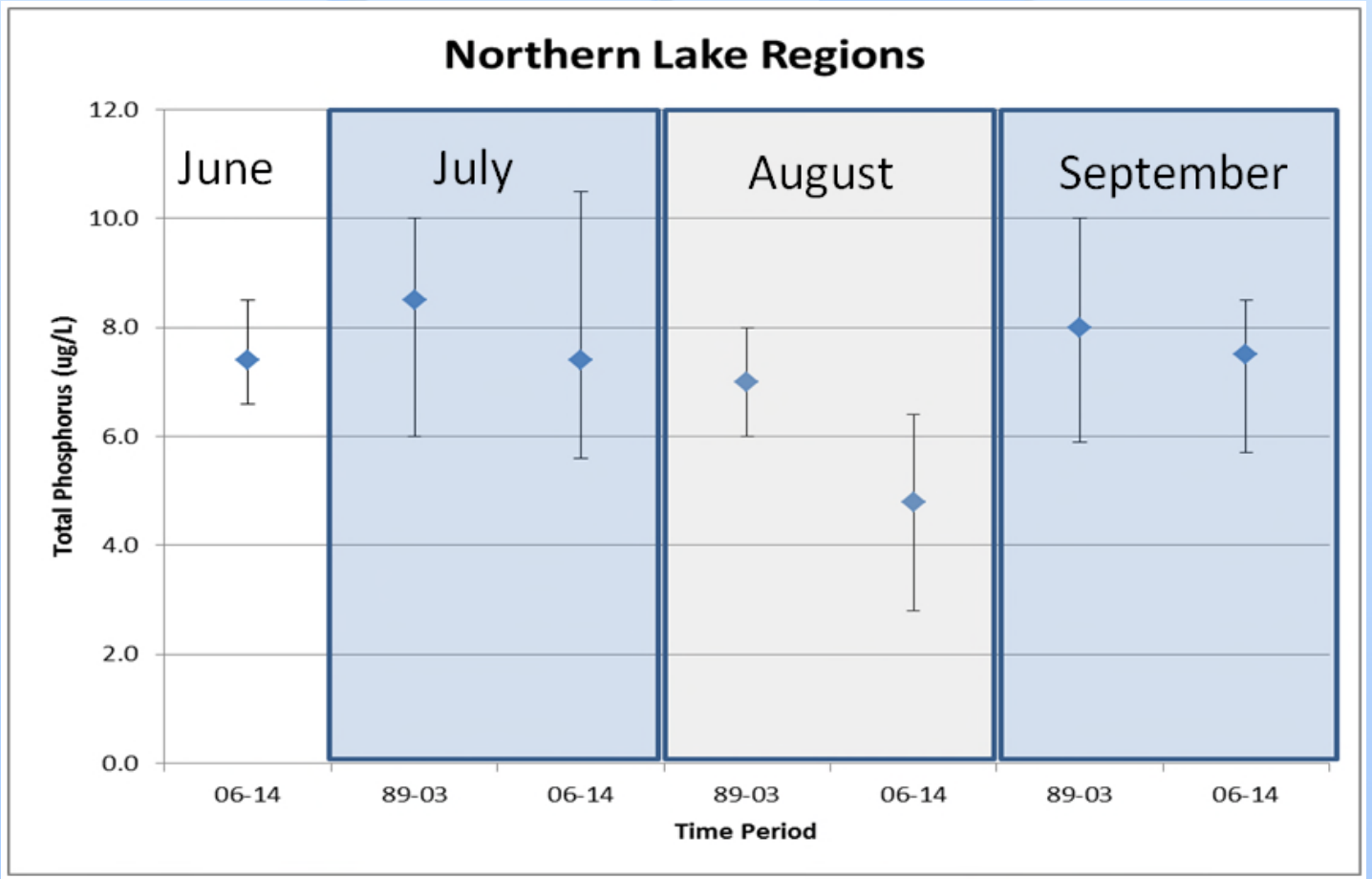
- monthly from June through September
- Profiles through the water column: temperature, pH, dissolved oxygen, electrical conductivity, and secchi depth.
- Photic zone aquatic chemistry: composite for analysis of total nitrogen, total phosphorus, and chlorophyll a.
- If the site is stratified, a grab sample is taken from the hypolimnion for analysis of total nitrogen, and total phosphorus.


Kootenai Bay
Oden Bay
Sunnyside
Trestle Creek
Bottle Bay
Ellisport Bay
Glengary Bay
Camp Bay
Garfield Bay
Talache Landing
Granite
Bayview North
Lakeview
Idywilde Bay
Lake Area
North
Mid
South
Pend Oreille Lake Watershed
N
0
5
10
Miles

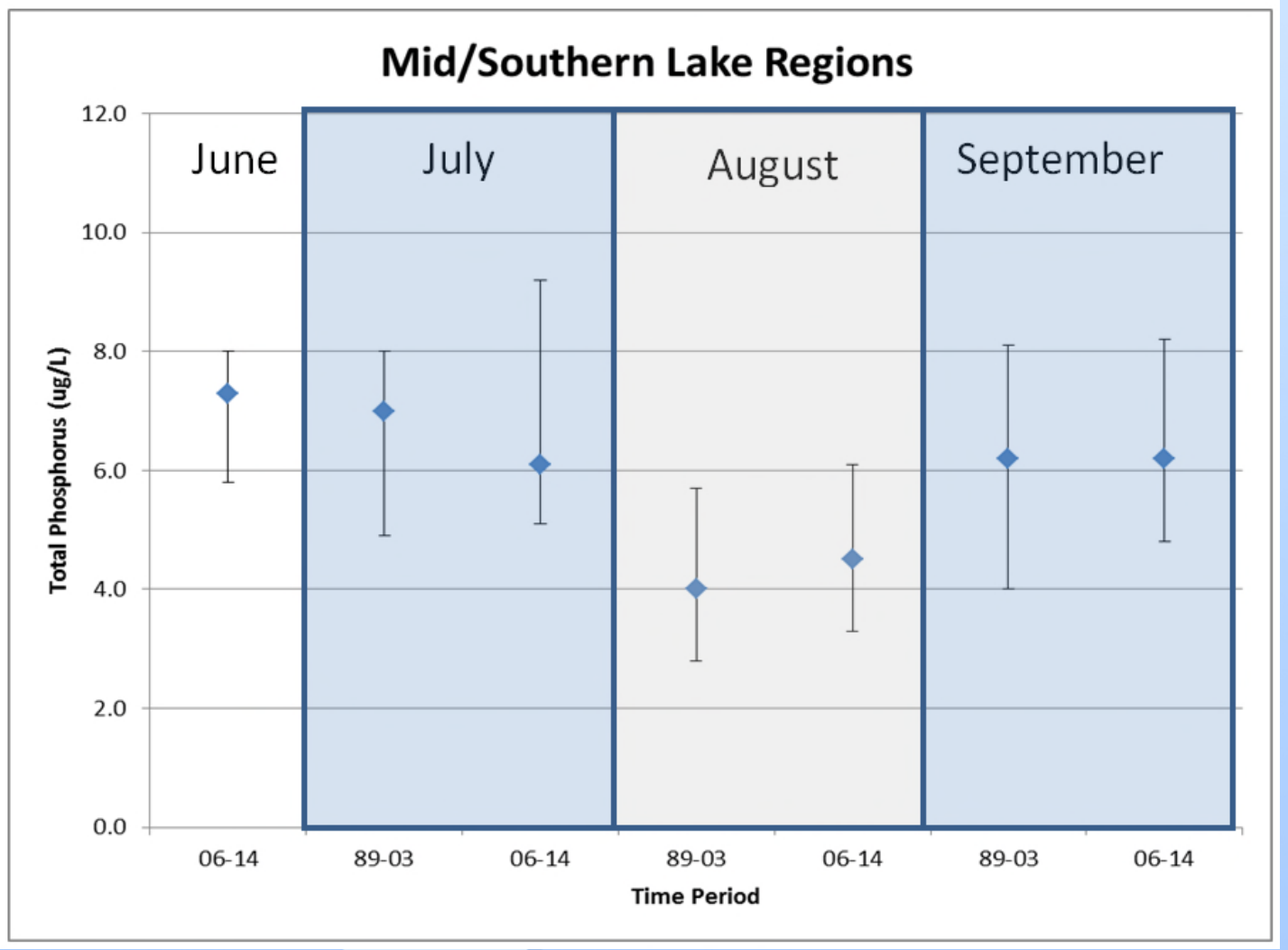
Median Total Phosphorus by location



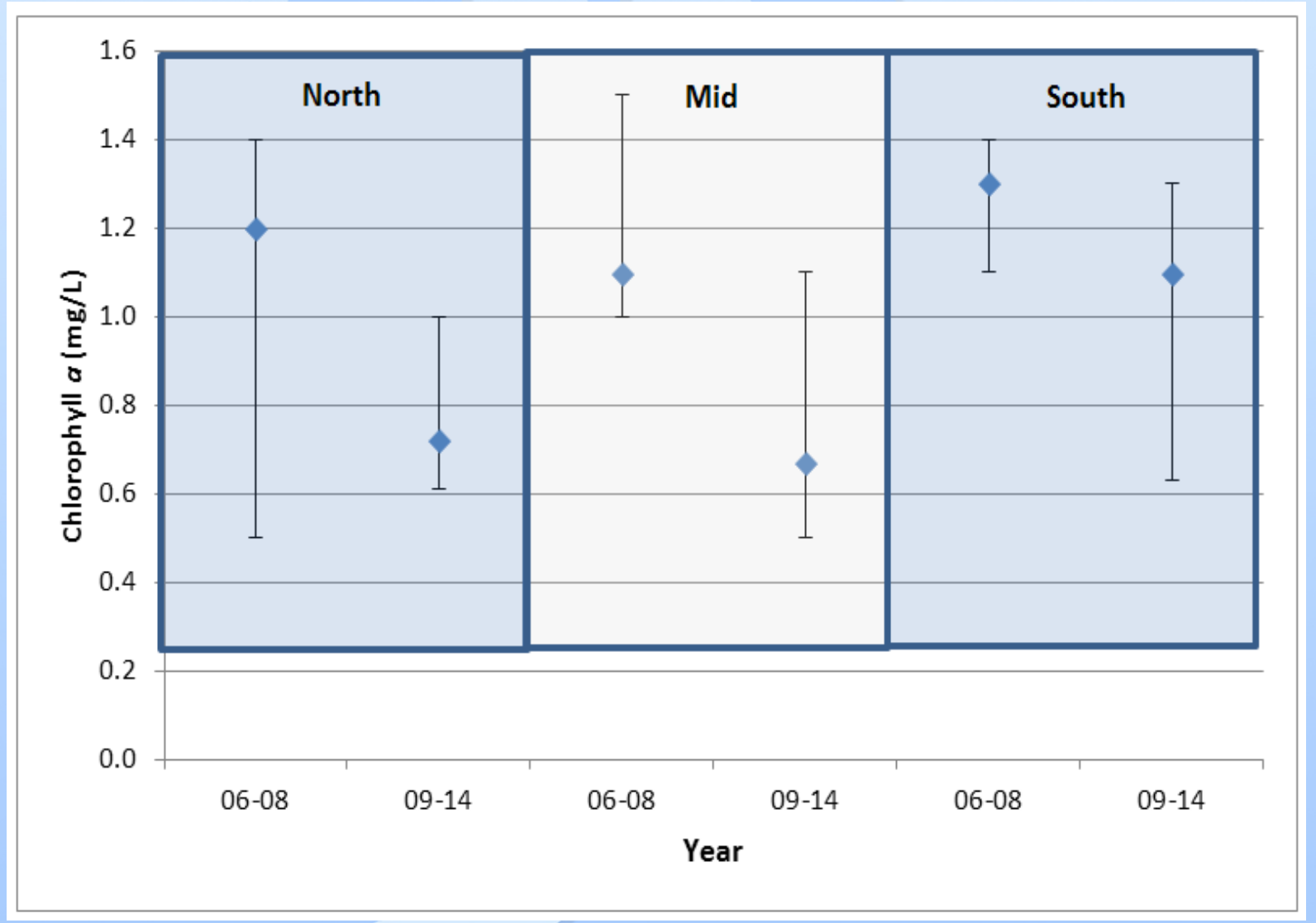
Median Total Phosphorus by Month



Median Total Phosphorus by Month



Chlorophyll-a



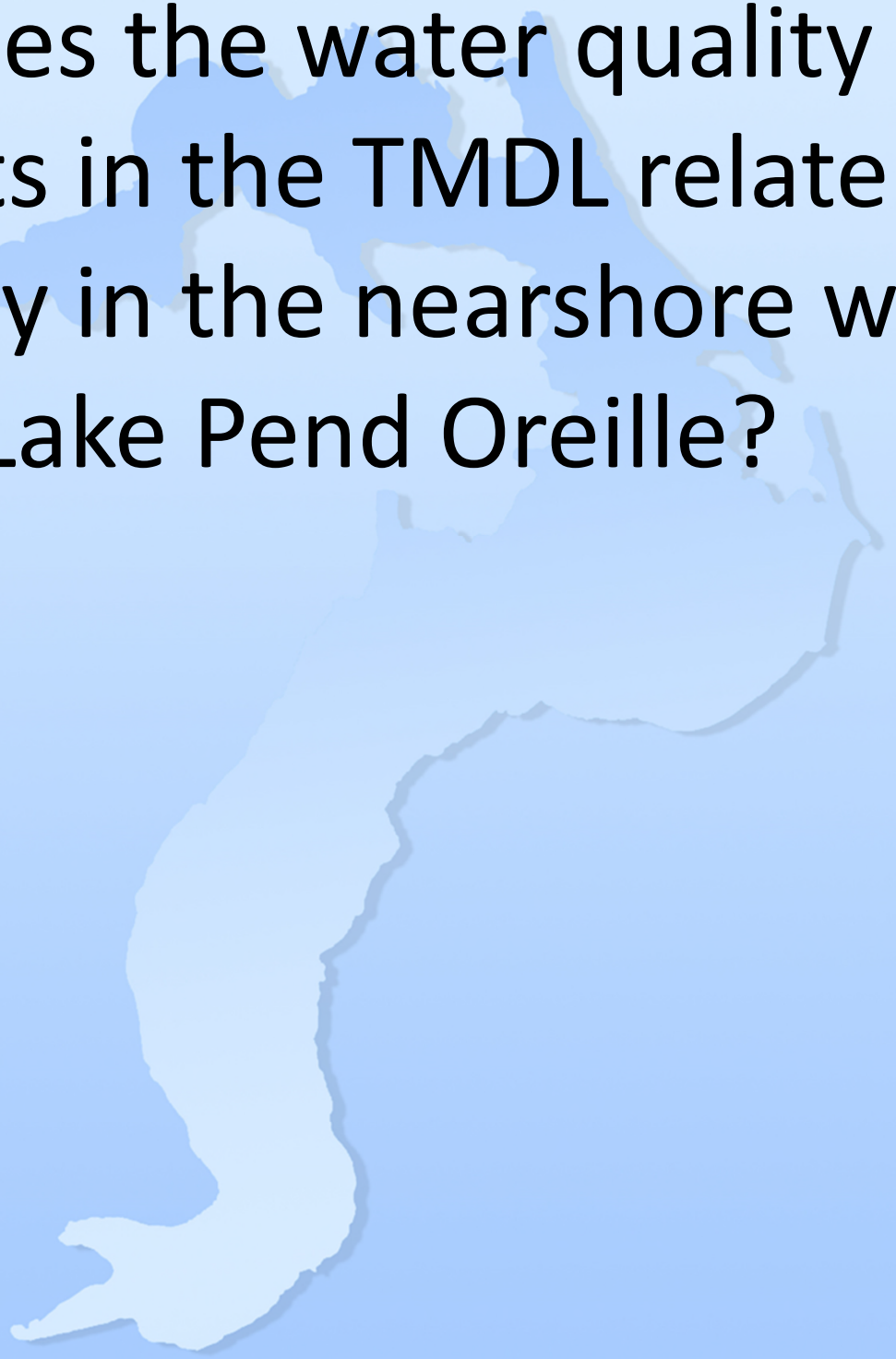
Are water quality targets in the TMDL being met?

Binomial Distribution Analysis

$$P(x \text{ “successes”}) = \frac{n!}{x!\,(n-x)!}\, p^{x}\,(1-p)^{(n-x)}$$

- Non-parametric analysis with a statistical approach to evaluate the *probability* of the TMDL target being exceeded based on the number of samples taken.
- Reduces the number of false positive and false negative errors
- Results determined the targets are not being met in the northern nearshore region of the lake, but they are being met in the mid and southern regions

How does the water quality and targets in the TMDL relate to productivity in the nearshore waters of Lake Pend Oreille?



Productivity Monitoring

- Another aspect of limnological investigations is the evaluation of benthic algae or periphyton,
- In addition to being the primary food source for aquatic insects, periphyton are considered early indicators for change in chemical and physical environmental factors within a lake.

Productivity Monitoring

- Artificial substrates were deployed at all nearshore stations, and they were visited weekly for the following 6 weeks.
- Periphyton samples were collected and analyzed for chlorophyll *a* concentrations each week to determine a rate of growth and a relative measure of productivity.
- During the retrieval, an additional periphyton sample was taken for periphyton taxa identification and enumeration.

Artificial Substrates

- Consists of an expanded polystyrene block mounted to plywood .
- The plywood is bolted to a piece of concrete flagstone to provide added support and ballast.

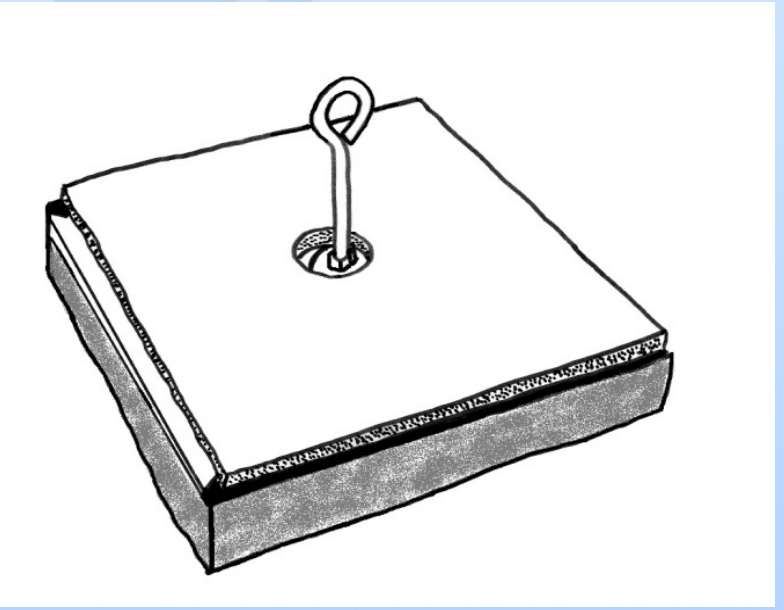
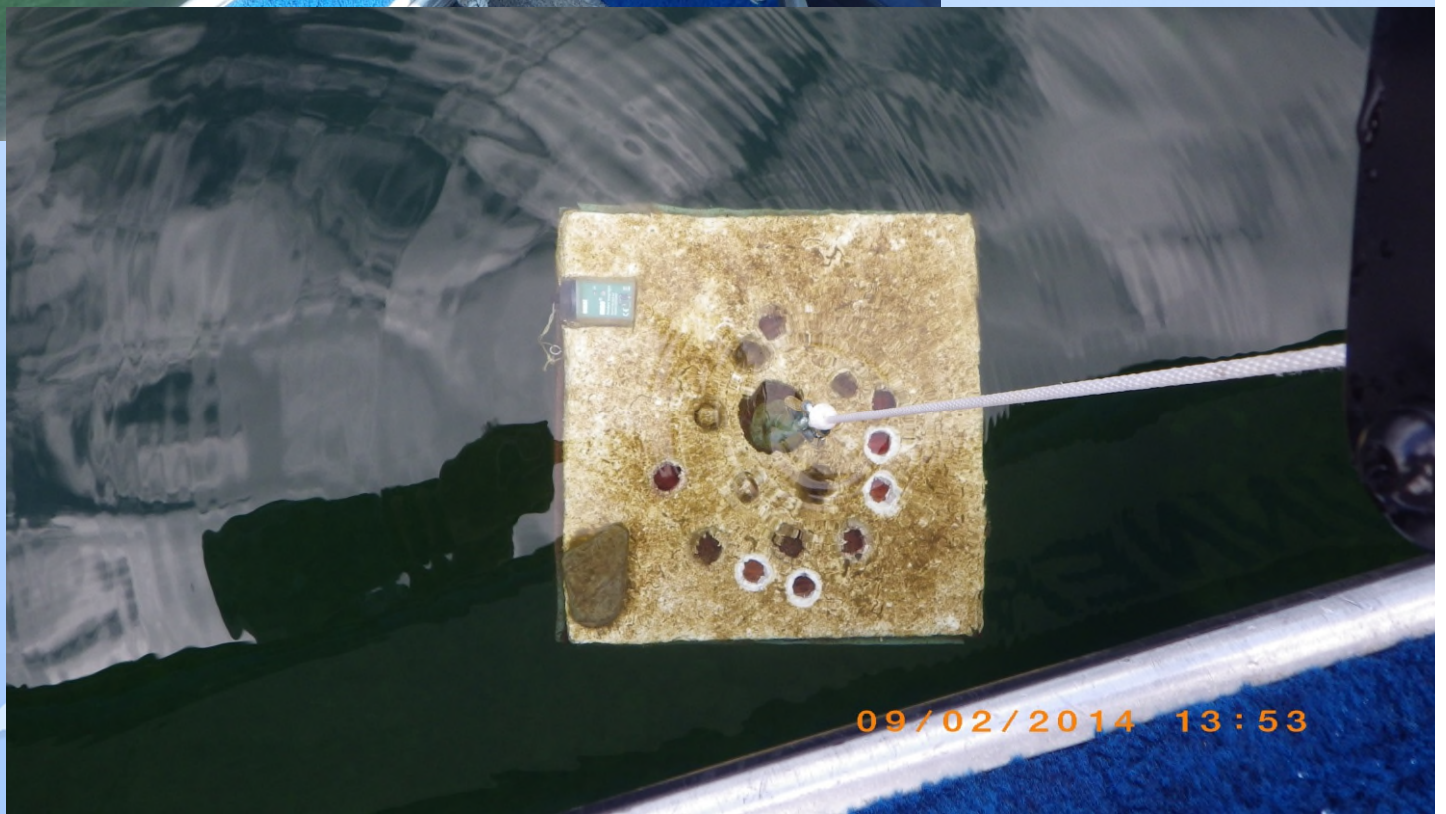


***Figure* 5. Illustration of artificial substrate.**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Chla Growth Rate

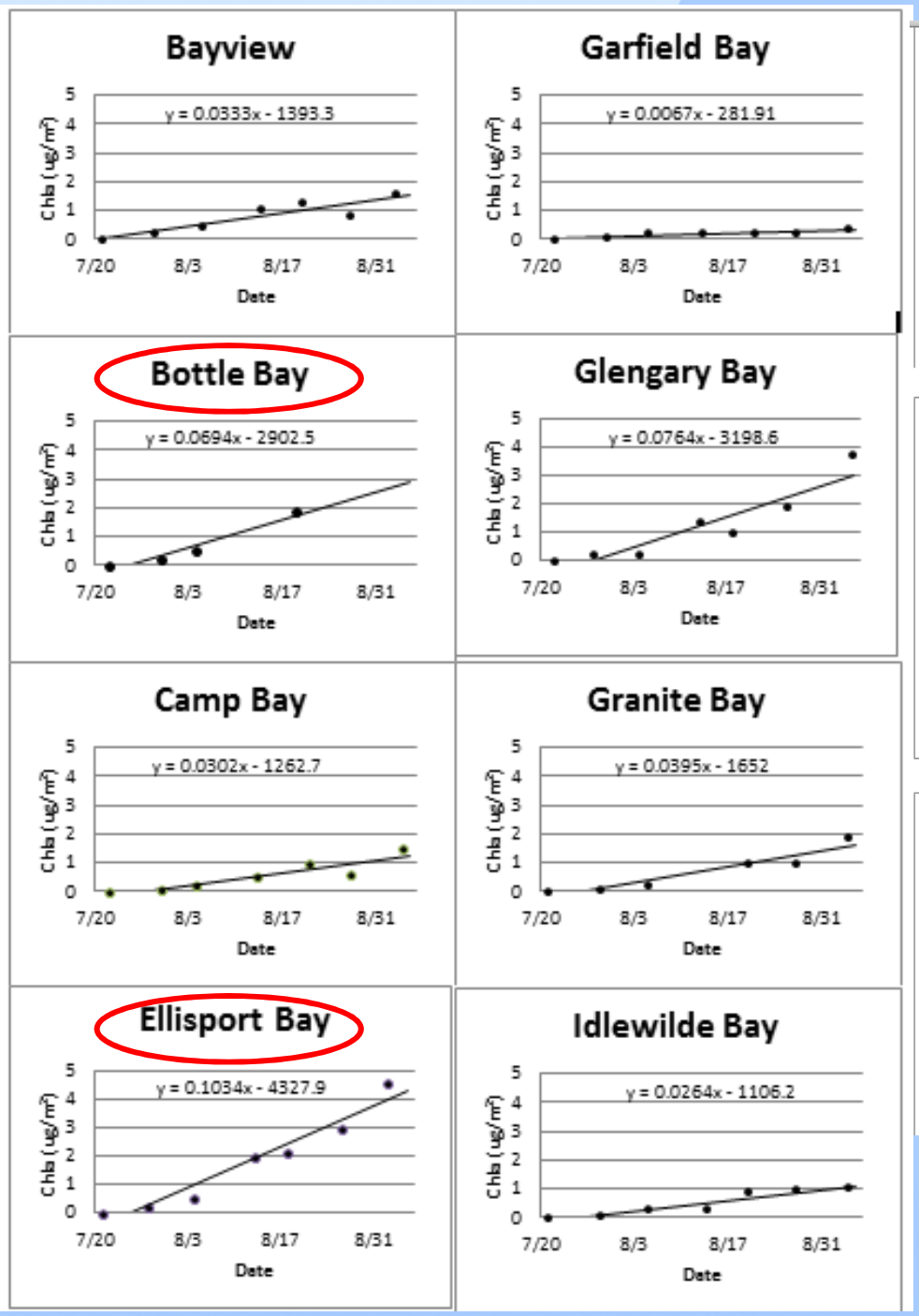
Kootenai Bay (North)

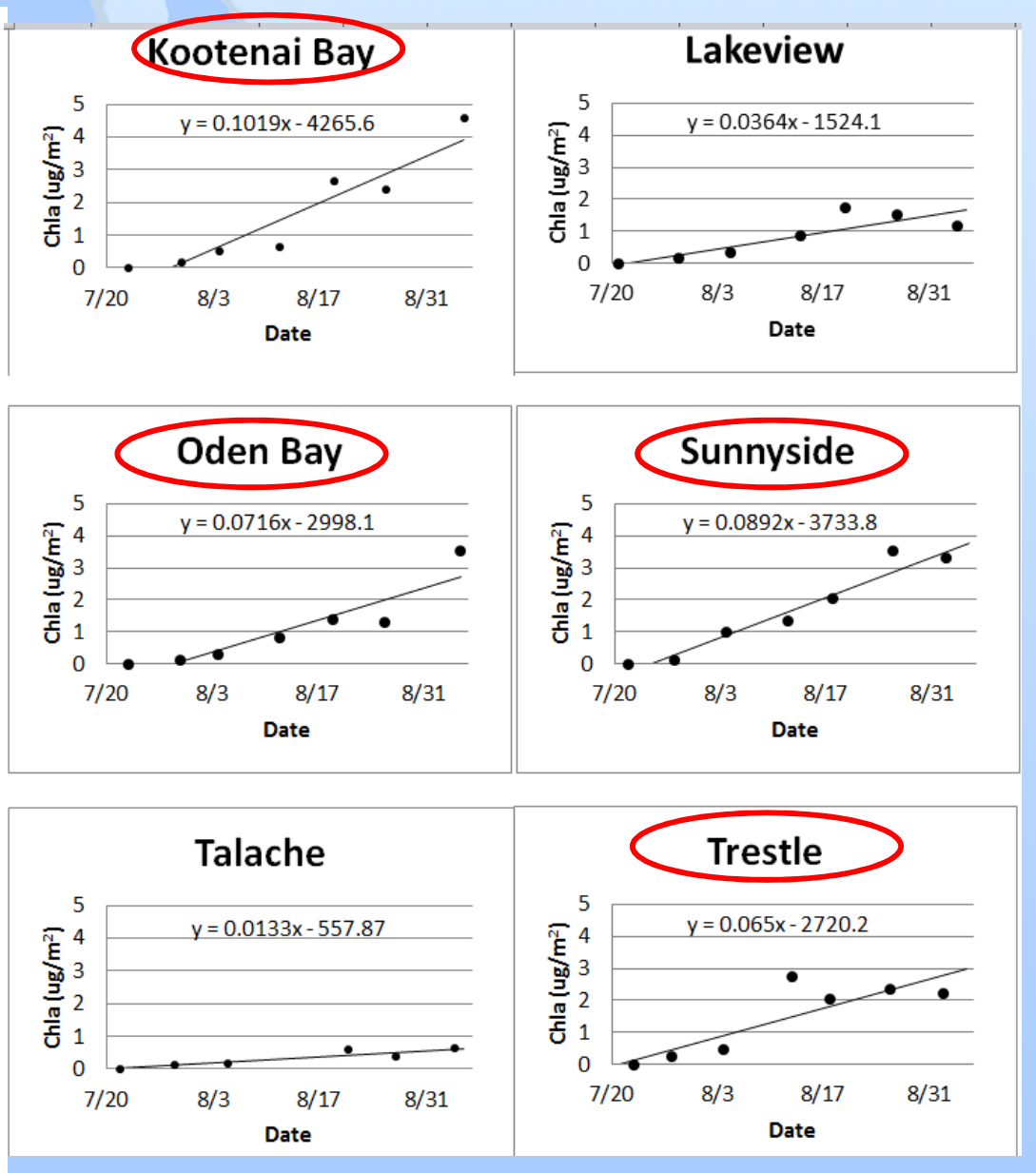
Idlewilde Bay (South)

Station Name	Alias	Chla growth rate ($ug/m^2/day$)	Maximum Chla (ug/m^2)
Ellisport Bay	North	0.103	4.58
Kootenai Bay	North	0.102	4.5224
Sunnyside	North	0.089	3.4818
Glengary Bay	Mid	0.076	3.7088
Oden Bay	North	0.072	3.5062
Bottle Bay†	North	0.069	2.898
Trestle	North	0.065	2.733
Granite	South	0.039	1.8642
Lakeview	South	0.036	1.7046
Bayview	South	0.033	1.5726
Camp Bay	Mid	0.030	1.4738
Idlewilde Bay	South	0.026	1.0762
Talache	Mid	0.013	0.6248
Garfield Bay	Mid	0.007	0.3894

†Bottle Bay maximum Chla projected from growth rate

Periphyton Chla Growth Rate





Productivity monitoring stations cell counts summary (in order of all taxon cell count).

		Cell Count (cells/cm2)					
Station Name	Alias	All Taxon	Diatom	Green Algae	Flagellate	Cyanobacteria	Dinoflagellate
Lakeview	North	2,000,000	84,000	540,000	8,800	1,400,000	
Trestle	North	1,300,000	220,000	990,000	22,000	88,000	
Oden Bay	North	1,100,000	79,000	600,000	13,000	380,000	
Kootenai Bay	North	960,000	62,000	620,000	18,000	260,000	
Sunnyside	North	880,000	120,000	400,000	22,000	350,000	
Camp Bay	Mid	820,000	40,000	400,000	8,800	380,000	
Glengary	Mid	800,000	92,000	430,000	4,400	270,000	4,400
Ellisport Bay	Mid	770,000	92,000	510,000	26,000	150,000	
Idlewilde Bay	South	630,000	35,000	270,000	8,800	320,000	
Granite	South	550,000	35,000	290,000	8,800	220,000	
Talache	Mid	480,000	53,000	250,000		170,000	
Bayview	South	440,000	53,000	260,000		140,000	
Garfield	South	340,000	31,000	240,000	8,800	62,000	

Summary

- The northern stations have the highest human influence and also the highest productivity.
- Chlorophyll *a* data suggest that water column nutrients in the northern portion of the lake support higher periphyton productivity than do the nutrients in the southern portion.
- If nutrients increase in the nearshore areas, it is likely that nuisance aquatic growths will further impair beneficial uses.
- The targets are appropriate for the nearshore areas of the lake

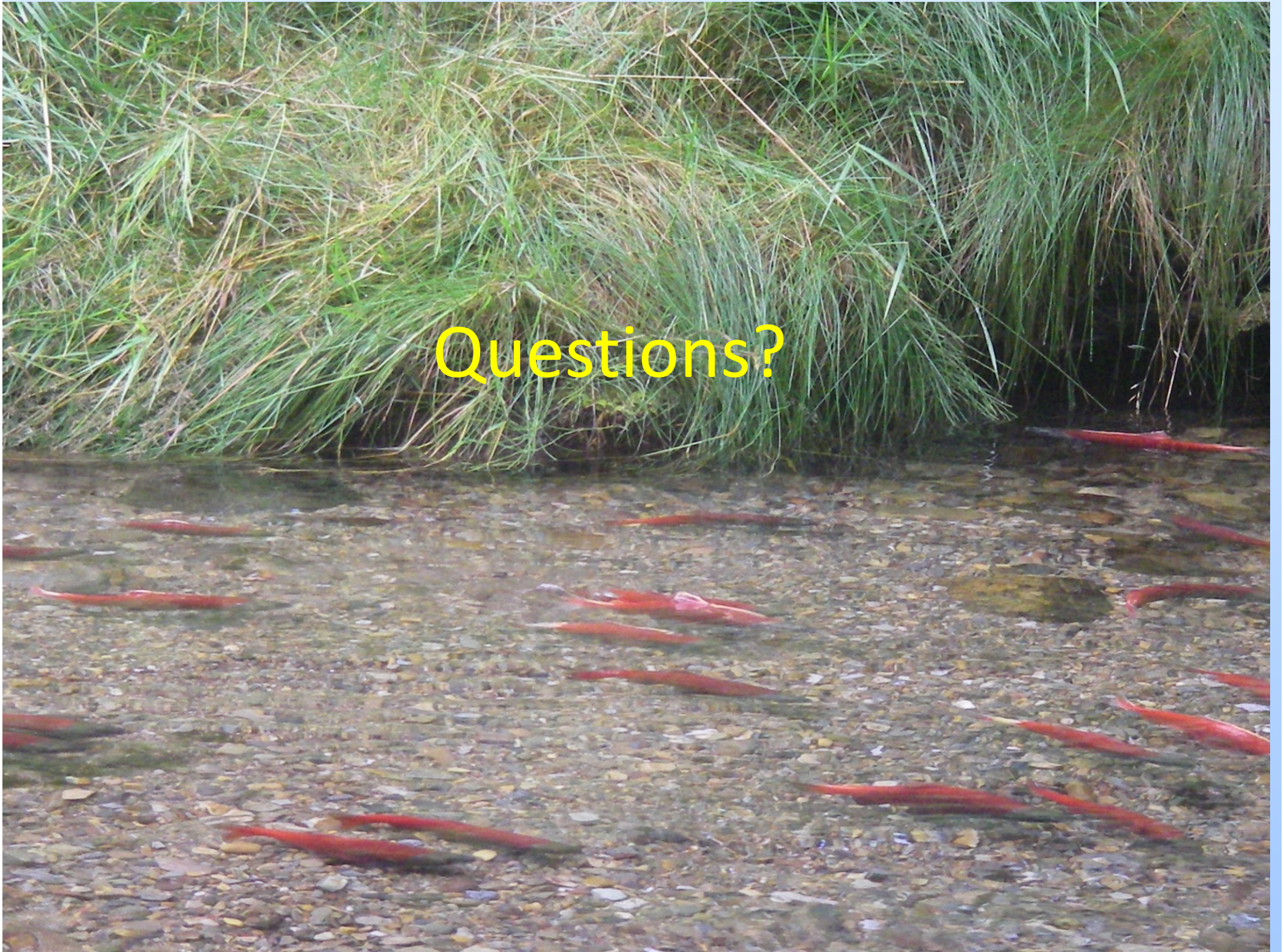
The TMDL assumes that the dominant factor affecting nearshore water quality is loading from the immediate nearshore drainage area, not from tributaries.
Is this assumption valid?

- The loading calculations did not take into account other loading sources to the lake. The following sources were not considered in the TMDL:
  - The Clark Fork River
  - The Pack River
  - Other tributaries to the lake
  - Specific stormwater from greater Sandpoint area, Hope, and Bayview

Summary of TMDL 5-Year Review

- **The TMDL targets of 9 µg/L and 12 µg/L are reasonable targets and should remain in place.**

- TMDL targets are not being met in northern region of the lake, and are being met in the mid and southern region of the lake.
- TP concentrations were significantly higher in north than in the mid and southern lake regions.
- TP concentration in the mid and southern have not changed significantly over time.
- Productivity in the northern lake is higher than the mid and southern regions of the lake.


Questions?